

Reducing Emergency Department Length of Stay: Designing an Evidence-Based  
Guideline for Oral Contrast Use in Abdominopelvic CTs

DNP Final Project

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### **Dedication**

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### **Abstract**

Prolonged emergency department length of stay has gained attention and momentum in the healthcare arena over the last several years. ED crowding and inefficient process of patients have negatively affected the quality of care, leading to increased inpatient mortality, adverse events, lengthier inpatient stays, and increased overall resource use. ED length of stay metrics within the project site consistently performs below state and national benchmarks. It is imperative for the organization to adopt evidence-based practice strategies to reduce ED length of stay and improve the overall patient experience.

The use of oral and intravenous contrast agents for patients who present with abdominal pain and receive an abdominopelvic CT is the current standard of practice in the project sites' ED. In the last decade, the use of oral contrast has become questionable in terms of distinct benefits to the quality of the exam. In many settings, providers use personal discretion to decide if oral contrast is truly beneficial. The purpose of this project was to construct an evidence based practice guideline to support the discretionary use of oral contrast in abdominopelvic CTs. In a large urban ED on the east coast, this interdisciplinary effort involved key stakeholders, including emergency medicine physicians, radiologists, general surgery and hospitalist providers, medical imaging technologists, and nursing and medical imaging leadership. Baseline data for contrast usage and associated cost was shared with the stakeholder group in addition to a draft evidence-based guideline for oral contrast use. After revisions, key stakeholders approved the guideline and a plan for implementation into current practice was developed to guide oral contrast use in abdominopelvic CTs to improve ED efficiency while maintaining equivocal CT results.

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## **Chapter I: Introduction to the Project**

With nearly 130 million emergency department (ED) visits across the United States yearly, EDs continue to be a major provider of healthcare related encounters (Centers for Disease Control and Prevention, 2012). During these visits, clinicians evaluate and treat patients across all levels of the acuity spectrum simultaneously. Due to the variability of diagnoses and treatment regimens, the time between a patient's arrival through departure or length of stay (LOS) in ED ranges from minutes to hours. This LOS is significantly affected by the length of time it takes for clinicians to evaluate and manage symptomology, complete advanced diagnostics, accurately diagnose, treat and complete clinical disposition.

Guidelines based on the best evidence promote system efficiencies and optimal quality outcomes (Melnik & Fineout-Overholt, 2011). Utilization of evidence based guidelines for the diagnostic evaluation of high volume ED patients can potentially improve department efficiencies and quality outcomes.

### **Background**

Multiple system inefficiencies have been identified that negatively effects the ED patient encounter, such as limited bed capacity, high patient volumes, limited staffing, and lengthy processes for diagnostic evaluation and treatment. These factors alone or in combination impact efficiency, creating delays affecting the department and impacting the system as a whole. Historically this has been viewed as exclusively an ED problem, however organizations are recognizing these delays are system issues which require interventions at multiple levels (American College of Emergency Physicians [ACEP], 2008). In 2008, the American College of Emergency Physicians urged organizations to view extended ED lengths of stay and boarding problems as a system issue, not just of an inefficient ED (ACEP, 2008). Beginning with patient

presentations at the point of triage, continuing through the process of evaluation and diagnosis, delays and inefficient workflows have negative impact on the patient experience, cost of care and access to care (Wiler et al., 2010). Advanced diagnostics such as laboratory and medical imaging exams, obstacles in the admission process, a lack of inpatient bed availability, lengthy stays for admitted patients, and slow discharge processes all contribute to overall system delays (ACEP, 2008).

Limited bed capacity is a multifactorial issue which adds to a cycle of inefficiencies, further bogging down the system and contributing to ED crowding. Factors include high numbers of patients presenting to the ED, inadequate staffing to run full patient assignments, lengthy processes for diagnostic evaluation and formulation of a treatment plans, and lack of consistent evidence based guidelines to direct patient care. These factors add time to the ED stay, increasing bed occupancy and consequently reducing bed availability for incoming patients. This repetitious cycle impacts the LOS for all patients. Regardless of presenting complaint or amount of diagnostics required, all patients presenting to the ED during a higher period of influx will experience lengthier ED visits due to decreased bed availability overall.

### **Significance**

ED crowding and inefficient processing of patients have negatively impacted quality of care leading to increased inpatient mortality and adverse events for decades (Flabouris, Jeyadoss, Field, & Soulsby, 2013; Hoot & Aronsky, 2008; Hwang, 2010; Intas, Stergiannis, Chalari, Tsoumakas, & Fildissis, 2012; McCaughey, Erwin, & DelliFraine, 2015; Moskop, Sklar, Geiderman, Schears, & Bookman, 2009; Mowery et al., 2011; Pines et al., 2008). From the time a patient arrives in the ED until discharge or admission to an inpatient bed, a visit of more than eight hours has been associated with a longer inpatient length of stay and the consumption of



more resources during the hospitalization (Chong, Haywood, Barker, & Lim, 2013). In addition, ED crowding has been linked to poor care in patients with severe pain, delays in medication administration for time-sensitive diagnoses (e.g. myocardial infarction, pneumonia, sepsis), and perception of compromised emergency care (Barrett & Schriger, 2008; Pines et al., 2007). In a 2011 study, Singer and others confirmed prior studies and found the time spent waiting for a ready inpatient bed in the ED added three days to the overall inpatient LOS.

Emergency department length of stay is also linked to mortality. In a multisite study of one million ED admissions, researchers found patients who were admitted on days in which the EDs were crowded had a 5 percent greater chance of dying during the inpatient admission, a 0.8 percent longer hospital length of stay, and a 1 percent increase in the cost of a single admission than patients seen on days without crowding (Sun et al., 2013). Cumulatively over the one year study, ED crowding was attributable to 300 inpatient deaths, an additional 6,200 hospital days, and 17 million dollars in cost (Sun et al., 2013).

Additionally, crowding has been shown to cause transport delays, delay in treatment for patients of all types, ambulance diversion, and patient elopement (Hoot & Aronsky, 2008). ED length of stay has also been directly tied to patient satisfaction: the shorter the length of stay, the more satisfied patients typically are with the ED visit (Walrath, Tomallo-Bowman, & Maguire, 2004).

In response to the literature citing adverse events and increased mortality related to ED crowding, the Centers for Medicare and Medicaid Services (CMS) published guidelines for quality metrics for EDs in 2013 to address the growing access to care crisis (CMS, 2013). Financial incentives have been implemented as a component of the value based purchasing program set forth by the Affordable Care Act. Organizations achieving top performance as

compared to peer groups for reduced ED length of stay will receive maximum CMS reimbursement (Agency for Healthcare Research and Quality [AHRQ], 2014). Organizations that do not address capacity and flow issues in the ED to reduce patient length of stay are at risk for losing money as part of the value based purchasing program (AHRQ, 2014). Due to the success of other pay for performance measures set forth by CMS, private insurers have adopted similar expectations (James, 2012).

Quality metrics in the evidence-based practice project site demonstrated consistent underperformance according to state and national benchmarks. These metrics include door to provider evaluation, overall outpatient and inpatient length of stays, as well as admission process time. The average length of stay for both admitted and discharged patients within the organization was over 300 minutes which was approximately two hours greater than top national performers (Medicare.gov [CMS], 2015). In the ED, the average time to see a provider was 58 minutes. Four percent of patients leave prior to a provider evaluation. These statistics are three times greater than the top performer's metrics (CMS, 2015).

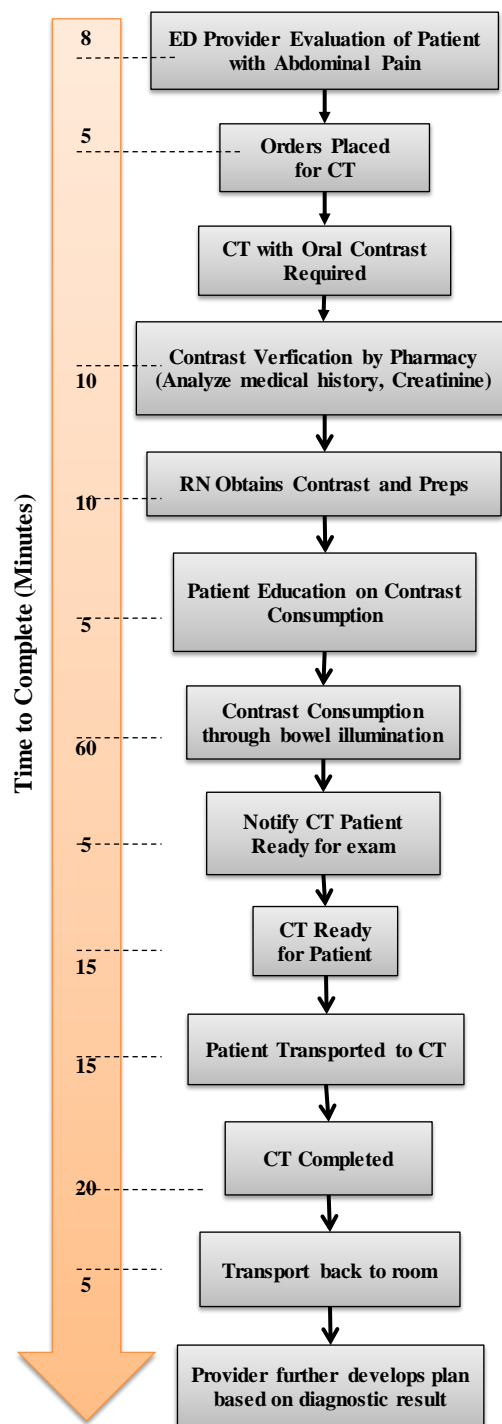
Nationally, while the rates of ED visits have decreased for some conditions such as minor trauma, the number of visits for abdominal pain requiring advanced diagnostics such as a CT exam has increased by eighteen percent over the last five years (Skinner et al., September 2014). Abdominal pain is one of the five most frequent presenting symptoms, accounting for approximately of ten percent of the total number (Weiss, Wier, Stocks, & Blanchard, June 2014; Kendall & Moreira, 2014). In the evidence-based project site, abdominal pain ranks as one of the three most frequent complaints of patients presenting in the ED (Mission Health, personal communication, October 6, 2015).

The standard diagnostic test for patients presenting with abdominal pain is an abdominopelvic CT to determine underlying etiology. Enteric contrast was originally administered to help radiologists differentiate intraenteric versus extraenteric anatomy (Razavi, Johnson, Kassin, & Applegate, 2014). Early CT technology required long image acquisition times because of movement artifact from respirations and bowel peristalsis (Lex, 2008). As a result, high volumes of oral contrast were required to ensure a quality image (Lex, 2008). It was low-cost with few known adverse effects. As technology has evolved, less imaging time is required and image quality has improved (Levenson et al., 2012; Razavi et al., 2014). The original rationale for oral contrast use is no longer valid.

### **Problem**

In 2015, over 100,000 patients were evaluated and treated in the emergency department at Mission Hospital (Mission Health, personal communication, October 6, 2015). Approximately 800 patients present with abdominal pain per month (Mission Health, personal communication, October 6, 2015). ED providers order oral contrast for abdominopelvic CTs frequently and inconsistently. The process for oral contrast agent ingestion takes several hours from the initial consumption to bowel illumination. This has significance for CT completion time and impacts the patient's ED LOS as illustrated in **Figure 1.1**.

■ **Figure 1.1.** Current Organizational Process for CTs Ordered with Oral Contrast



*Figure 1.1.* Components of CT oral contrast process from provider evaluation until patient disposition.

An official guideline for oral contrast use is lacking. The American College of Radiology expresses a neutral opinion, leaving decision making for oral contrast use to organizational preference (American College of Radiology [ACR], 2014). The site for this evidence based project currently lacks a specific guideline.

In general, providers prescribe the use of oral contrast in abdominopelvic CTs based on their experience and personal practice preferences resulting from their current understanding of what they believe to be best practice.

### **Purpose**

The purpose of this project is to construct an evidence based practice guideline for abdominopelvic CTs for the use of oral contrast. The clinical question is “In adult patients with abdominal pain (*Population*), how does a guideline (*Intervention*) compared to provider preference (*Comparison of Interest*) affect appropriate use of oral contrast (*Outcome*)?”

### **Significance to Healthcare and DNP Essentials**

The number of EDs has decreased by twenty-five percent in the last five years, while the demand for ED care has grown significantly (Barish, McGauly, & Arnold, 2012; Centers for Disease Control and Prevention, 2013; Skinner, Blanchard, & Elixhauser, September 2014). Many hospitals are operating “at” or “over” their capacity (Schneider, Gallery, Schafermeyer, & Zwemer, 2003). With limited capacity, EDs are unable to provide timely, efficient, and effective patient care. Evidence-based strategies can be used to streamline processes and maximize efficiencies to potentially reduce ED length of stay and improve outcomes.

The Doctor of Nursing Practice (DNP) leader has the expert knowledge and skill set to champion and direct evidence-based practice changes that streamline inefficient system processes. The DNP registered nurse combines system and clinical knowledge, expert skill, and

the integration of best practice as determined by research for system improvements (Zaccagnini & White, 2014). This evidence based practice project demonstrated several of the DNP Essentials defined by the American Association of Colleges of Nursing (AACN, 2006).

- Essential I: Scientific underpinnings for practice - The proposed evidence-based practice project demonstrates this essential through integration of current evidence into a guideline for oral contrast use in abdominopelvic CTS.
- Essential II: Organizational and Systems Leadership for Quality Improvement and Systems Thinking and Essential IV: Interprofessional Collaboration for Improving Patient and Population Health Outcomes – In this project, the DNP assumed a leadership role in guiding an interdisciplinary team through process of developing a guideline for oral contrast use in the ED based on Lewin’s change theory.
- Essential III: Clinical Scholarship and Analytical Methods for Evidence-based Practice – Analysis and synthesis of the evidence provided support for the design, content and evaluation of this project to promote safe, timely, effective, and efficient patient care within the ED.
- Essential VIII: Advanced Nursing Practice – This essential is illustrated through demonstration of advanced levels of clinical judgement, systems thinking, accountability and communication skills in leading the interdisciplinary effort to design an evidence-based practice guideline (AACN, 2006).

### **Project Objectives**

The mission of the organization is “to get each patient to the desired outcome, first without harm, also without waste and with an exceptional experience for the patient and family”

(Mission Health, 2014, para. 2). Aligning with the mission of the organization, the proposed practice change will achieve the desired outcome by eliminating waste (both time and oral contrast material) and contributing to an improved patient experience. This evidence based practice project has three main objectives:

1. To develop an evidence based guideline for use of oral contrast in abdominopelvic CTs
2. To increase the efficiency in the diagnostic process of patients presenting with abdominal pain in the ED
3. To demonstrate the role of the DNP in designing and implementing an interdisciplinary, evidence-based practice change.

The project objectives align with the overall organizational initiatives to reduce ED length of stay by increasing bed availability and subsequently expediting access to ED, consistent with industry standards and the organization's mission and values. They support key strategic priorities for the organization for the next three years include achieving the highest quality nationally and break-even operating standards or better with CMS performance metrics (Mission Health, 2014).

### **Conclusion**

The DNP will lead an interdisciplinary effort to design an evidence-based strategy to potentially impact ED efficiency. An evidence-based guideline for oral contrast use in abdominopelvic CTs will be developed for use.

## **Chapter II: Review of the Literature**

Evidence-based practice projects are guided by in-depth literature review, sound nursing theory and a fundamental model for evidence-based practice. Combined with evidence, these frameworks guide project design, implementation, and evaluation. Kurt Lewin's change theory and Rosswurm and Larrabee's model of evidence-based practice are applied in this project.

### **Theoretical Framework**

#### **Model of Evidence-Based Practice**

Rosswurm and Larrabee's model for evidence-based practice (EP) will be utilized for this evidence-based practice change. Utilizing this model, the team will use a systematic process to plan and implement the practice change to reduce time to CT scan while maintaining a high standard of clinical care (Rosswurm & Larrabee, 1999). The steps of the model include assessing the need for change in practice, linking problem with potential interventions and outcomes, synthesizing best evidence, designing the practice change, implementing and evaluating the change, and integrating and maintaining the change in practice (Rosswurm & Larrabee, 1999). This model was chosen for its ease of use and general applicability to various settings and diagnoses. Application of the steps of the model to the project are as follows:

***Step one: Assess the need for change in practice.*** The organization is seeking evidence-based practice changes to eliminate waste and improve ED throughput (CMS, 2015). Quality data shows the ED is currently performing below state and national averages for overall ED length of stay (CMS, 2015). Patient populations with lengthy ED encounters is a priority focus. One of the highest volume complaints presenting to EDs, abdominal pain patients often have ED visits far longer than many other diagnoses. Additionally, provider ordering practices for oral



contrast in abdominopelvic CTs varies significantly across the organization without a standard guideline for the use of oral contrast.

***Step two: Link problem to potential interventions and outcomes.*** The use of evidence-based practice change in the clinical setting ensures both the transition to best practice as well as the standardization of care (Melnik & Fineout-Overholt, 2011). An evidence-based practice change that has been successful in improving ED efficiency is developing clinical guidelines for the use of oral contrast in abdominopelvic CTs (Razavi et al., 2014). The elimination of the time it takes for patients to drink contrast in preparation for the exam can reduce the wait time in the ED (Razavi et al., 2014).

***Step three: Synthesize best evidence.*** The literature review was guided by the key words in the clinical question (PICOT) and critically appraised. The best evidence will be incorporated into the oral contrast guidelines.

***Step four: Design practice change.*** Key actions in this step include defining the practice change, identifying needed resources, and designing the implementation plan and subsequent evaluation (Melnik & Fineout-Overholt, 2011). For the purposes of this project, the project coordinator will focus on designing the practice change and identifying needed resources. Initial actions will include the formation of an interdisciplinary group to share baseline organizational information related to efficiency and the current process for abdominopelvic CTs that require oral contrast.

***Step five: Implement and evaluate the change in practice.*** Implementation and evaluation of the change in practice are not within the scope of this student project.

***Step six: Integrate and maintain the change in practice.*** Since implementation and evaluation are not occurring as part of this student project, integration and maintaining in clinical practice will not be addressed.

### **Lewin's Change Theory**

Kurt Lewin's change theory will be used to guide the approach to the proposed EBP project. Grounded in action research in which Lewin's Change theory focuses on a practical problem to be solved, the theory has three distinct phases: unfreezing, change, and refreezing (Holter & Barcott, 1993; Petiprin, 2015). In the unfreezing phase, the organization finds a method for people to let go of an old pattern that is counterproductive. During the change phase, there is a change in thoughts or behaviors. In the last phase, the refreezing phase, the established change is the new normal and becomes the standard for practice (Holter & Barcott, 1993 ).

The process of developing an evidence-based guideline is consistent with the initial "unfreezing" phase of the Change Theory. In this initial phase, an interdisciplinary team of key stakeholders will be formed to identify the details of current practice, share baseline data, and discuss proposed evidence based guideline for oral contrast use. The context in which providers currently prefer oral contrast will be discussed as well as the openness to the practice change. Based on the feedback of stakeholders, the recommendations for change in ordering practices will be incorporated in the design of the new guideline. Once the guideline is finalized, the project site will move to the next phase of the Change Theory, "change" and "refreezing." Both of these phases will occur during the implementation of the evidence-based guideline after completion of the student project.

## **Related Research**

### **Searching for the Evidence**

Multiple databases were used to search for relevant literature about the use of oral contrast in CT procedures. These included: Academic Search Complete, Academic Search Premier, MEDLINE, CINAHL (Cumulative Index to Nursing and Allied Health Literature), Health Source: Nursing/Academic edition, National Guidelines Clearinghouse from the Agency for Healthcare Research and Quality, the Cochrane Collection and Google Scholar. Professional organization websites such as the American College of Radiology and the American College of Emergency Physicians were examined for recommendations.

### **Key Words**

In order to eliminate any non-abdominopelvic CT research that might populate into the results, the specific vocabulary headings of “adult,” “abdominopelvic computed tomography,” “abdominal CT,” “pelvic CT” were used. Additional terms included “oral contrast,” “enteral contrast,” and “positive contrast agents.” To generate information specific to guideline use in clinical practice, the keywords of “guidelines” and “provider” were used. Additional searches were performed for researchers Robin Levenson, Liu Huynh, and Seyed Amirhossein Razavi, physician experts, who have researched and published citations on the impact of no oral contrast guideline and emergency department length of stay (Huynh et al., 2004; Levenson et al., 2012; Razavi et al., 2014). In a review of the literature, three major themes were identified and categorized: efficiency in ED, equivocal CT results and guideline development and utilization.

### **Limits**

Limits were applied when searching the databases. Only the last ten years (2005-2015) of relevant documents were reviewed. Additionally, only academic journals were searched.

While there is a significant amount of literature on CT examinations, only research including CTs of the abdomen or pelvis were included.

### **Detailed Evidence Review**

One hundred and forty-five articles were identified through database searching. Fourteen additional articles were identified through other internet sources. In the process of screening, 123 records were found after removing duplicates, however only 84 records were screened. Of these, 30 records were excluded because they did not specifically address the clinical question and population of interest. After the search limits were applied, 54 full text articles were assessed. Thirty-two of the full text articles were excluded for not being research related to oral contrast in abdominopelvic exams or because research was completed on pediatric populations. After applying all PRISMA guidelines, the remaining studies were divided into two groups of literature. In the first group, seven studies specifically addressed radiology turnaround times and ED length of stay for abdominopelvic CTs. In the second group, fourteen studies identifying the equivalence of oral contrast CTs versus non-oral contrast CTs were carefully reviewed and categorized.

Oral contrast agents have been used to identify pathology during CTs for patients with abdominal pain (Levenson et al., 2012). Based on ED provider oral contrast preference, the patient is instructed to drink several ounces of oral contrast over several minutes after the initial abdominopelvic CT is ordered. After consumption, the contrast takes approximately 45-60 additional minutes to reach the cecum, increasing scan time by one to two hours (Anderson et al., 2005). Evidence surrounding the utilization and necessity of oral contrast has been questioned over the past several years, specifically because of additional time requirements for procedure

with questionable clinical benefit (Levenson et al., 2012). Two main themes were identified in the evidence: Efficiency and equivocal results.

### **Efficiency in ED.**

Several studies describe potential time savings accomplished by eliminating oral contrast use in abdominopelvic CTs within the ED. Eliminating the requirement for oral contrast for abdominopelvic CTs in the emergency department will reduce time from the CT order to completion of exam in the adult population (Huynh et al., 2004; Levenson et al., 2012; Razavi et al., 2014). Authors Hopkins et al completed a retrospective case controlled study of patients with abdominal pain excluding those who were post-operative or had complex underlying issues. Eliminating the oral contrast requirement cut the ED length of stay in half for patients discharged to home or transferred to the operating room (Hopkins, Madsen, Foy, Reina, & Barton, 2012). In a prospective randomized study of 244 patients, the median time to disposition from the ED was an hour and thirty-one minutes faster for patients who did not receive oral contrast (Kepner, Bacasnot, & Stahlman, 2012). Razavi and others conducted an observational study of 6409 ED patients requiring an abdominopelvic CT, excluding those with recent gastrointestinal surgery or clinical concerns for abdominal fistulas or abscesses. Patients who received IV only contrast had a median 43 minute reduction in overall ED length of stay compared to those receiving both oral and IV contrast (Razavi et al., 2014). In a 2010 retrospective cohort study, 1806 patients requiring abdominopelvic CTs had a half an hour overall median reduction in their total length of stay and 27 minute reduction in order to CT completion time (Schuur et al., 2010). Huynh and others completed a retrospective descriptive study of 258 patients in which patients receiving IV only contrast had a 68 minute reduction in CT order to completion and an overall 241 minute reduction in overall ED length of stay (Huynh et al., 2004). In 2012, authors completed a

retrospective quality assurance evaluation of 2001 ED patients receiving abdominopelvic CTs excluding those from the study with known inflammatory bowel disease, gastrointestinal tract-altering surgery, or those with lean body habitus: Those who received IV contrast only had a 66 minute reduction in CT order to completion and an overall 97 minute reduction in ED length of stay (Levenson et al., 2012).

### **Equivocal CT results.**

Researchers have demonstrated CTs completed without the use of oral contrast prior to the exam yields results equivocal to those performed when oral contrast was used for patients with undifferentiated abdominal pain (See *Appendix C*, Table 3, and *Appendix D*, Table 4) (Allen et al., 2004; Anderson, Salem, & Flum, 2005; Broder, Hamedani, Liu, & Emerman, 2013; Buttigieg, Grima, Cortis, Soler, & Zarb, 2014; Glauser, Siff, & Emerman, 2014; Hill, Johnson, Owens, Gerber, & Senagore, 2010; Holmes et al., 2004; Kammerer et al., 2015; Kepner et al., 2012; Laituri et al., 2011; Lee, Haaland, Earnest, & Tan, 2013; Lee et al., 2006; Stuhlfaut et al., 2004). In 2012, Kepner et al completed a prospective randomized study of 227 patients requiring abdominopelvic CTs. In this study, patients who received IV contrast only compared to IV and oral contrast had comparable diagnostic performance. A retrospective cohort study published of 661 patients receiving abdominopelvic CTs demonstrated no significant difference in the accuracy of CT diagnosis when any combination of contrast was used compared to CTs performed without oral contrast (Hill et al., 2010). Laituri and others completed a retrospective cohort study of 1561 patients in which nearly thirty percent of patients receiving oral contrast for the CT did not have contrast reach the area of interest, concluding there is no diagnostic compromise in those patients who would not receive oral contrast (Laituri et al., 2011). In a retrospective cohort study of 246 patients who underwent abdominopelvic CTs, authors found

the diagnosis of appendicitis was high regardless of oral contrast use and determined oral contrast agents for CT diagnosis should not be recommended (Latifi et al., 2011). A systematic review of 23 studies (3474 patients) receiving abdominopelvic CTs concluded IV only CT techniques to diagnoses appendicitis showed equivocal or better diagnostic performance compared to patients receiving both oral and IV contrast (Anderson et al., 2005).

### **Guideline Development**

In addition to individual knowledge, skills, clinical experience, and patient and family preferences, providers rely on scientific evidence to make informed decisions for patient care. Designed to be flexible and adapt to the unique needs of individual patients, clinical practice guidelines are statements based on best evidence and assessment of the risks and benefits of alternative care options (Institute of Medicine of the National Academies [IOM], 2011).

Widespread adoption of clinical practice guidelines has lagged behind production for many reasons. Some of these reasons include failure to represent a variety of disciplines during development, lack of transparency in how recommendations were made, and omission of a thorough review process all leading to mistrust in the guidelines by providers (IOM, 2011). In 2011, the IOM published specific standards for the guideline development. These standards include:

- Establish transparency in the development and funding of the guideline.
- Manage conflict of interest in guideline development group.
- The guideline development group has multidisciplinary representation of clinicians, experts and populations potentially affected by guideline.
- Based on systematic reviews that meet standards set forth by the Institute of Medicine
- Provide an explanation and rating strength based on the supportive evidence.

- Articulate recommendations in a standardized form outlining the circumstances in which the guideline is to be followed.
- Relevant stakeholders perform an external review of the guideline.
- Monitor and update the guideline regularly based on current evidence (IOM, 2011).

Increasing familiarity and awareness with the guideline, agreement with guideline, and changing physician behaviors surrounding guideline usage have been shown to be successful strategies at improving guideline adherence and ultimately reducing variation in practice (The McDonnell Norms Group, 2006).

### **Conclusion**

In summary, there is evidence demonstrating equivocal results without the utilization of an oral contrast agent in abdominopelvic CTs. There is a direct correlation to improving ED efficiency as well as evidence to support the use of guidelines to drive changes in practice (Anderson, Salem, & Flum, 2005; Hopkins, Madsen, Foy, Reina, & Barton, 2012; Huynh et al., 2004; Kepner, Bacasnot, & Stahlman, 2012; Levenson et al., 2012; Razavi, Johnson, Kassin, & Applegate, 2014; Schuur, Chu, & Sucov, 2010). There were no specific guidelines or algorithms for oral contrast use in abdominopelvic CTs found in the literature. Consequently, the project coordinator and stakeholder group will create an original guideline based on the synthesis of current evidence.



### **Chapter III: Methods**

The purpose of this chapter is to outline the methodology for this evidence-based practice project. The project design, methodology, instruments, and data analysis plan will be discussed.

#### **Design**

Clinical guidelines allow for integration and application of evidence within the clinical setting in a standardized approach to improve and ensure quality outcomes. Developing the guideline for use of oral contrast in abdominopelvic CT scans will be accomplished through an interdisciplinary, collaborative effort with representatives from all of the disciplines currently involved in the multi-step process for performing a CT examination. As stakeholders participating in a focus group, key clinicians will not only offer their expert opinion on the development of the guideline for oral contrast use, but also facilitate the “unfreezing” of other colleagues’ behaviors when the guideline is implemented.

#### **Methodology**

The guideline development for use of oral contrast in abdominopelvic CT scans will be a multistep process involving both the project site administrative representatives and designated clinical stakeholders. The sequential steps, timeframe, and responsible party are as follows:

1. Identified the need for improved efficiency in ED patient care processes or procedures through project site quality metrics. (January through June 2015 – Completed by project site)
2. Assessment of patient care processes with lengthy ED visits and associated reasons for extended length of stay. (July 2015 – Completed by project site)

3. Gathered and synthesized evidence promoting the practice change for oral contrast use in abdominopelvic CTs. (August 2015 through December 2015 – Project coordinator)
4. Identification of evidence-based initiative to reduce ED length of stay for abdominal pain patients requiring abdominopelvic CT. (August 2015 – Project coordinator)
5. Completed university requirements for planning and executing an evidence-based practice project. (December 2015 – Project coordinator)
6. Satisfied organizational requirements to conduct project within organization as a student led initiative. (December 2015 through January 2016 – Project coordinator)
7. Identified key stakeholders within the organization to collaborate on the evidence based guideline. (February 2016 – Project coordinator)
8. Gathered baseline data: oral contrast use in CTs, cost analysis. (February 2016 – Project coordinator)
9. Project coordinator collected, reviewed and synthesized best evidence and integrated into draft guideline. (February 2016 – Project coordinator)
10. Presented baseline data and draft oral contrast guideline to stakeholder focus for input, including suggestions for revisions and the identification of any potential barriers and challenges for implementation. (March 2016 – Project coordinator)
11. Revision of draft. (March 2016 – Project coordinator)
12. Presented revised guidelines to stakeholders with goal of unanimous acceptance. (March 2016 – Project coordinator)
13. Discussed plans for implementation. (March 2016 – Project coordinator and stakeholders)

(See *Appendix E* for a comprehensive timeline of project activities.)

The design of this evidence-based practice project is consistent with the steps of Rosswurm and Larrabee's model for evidence-based practice and Kurt Lewin's change theory. Following the steps of the evidence-based practice model, the project coordinator used the development of the oral contrast guideline to move clinicians through the "unfreezing" phase of the change theory.

### **Project Development**

The setting for this project was in the emergency department of an urban 63 bed emergency department with a level two trauma center in the eastern region of the United States. Providers completing diagnostic evaluations of patients include a group of 55 medical doctors and advanced practitioners (e.g. Nurse Practitioner, Physician Assistant). Thirty-three providers within the group are medical doctors, while 22 are advanced practitioners split evenly between Nurse Practitioners and Physicians Assistants. The department is staffed with seven physicians and five advanced practitioners during the highest patient volumes. Provider experience in the ED varies from novice to expert with the average provider having approximately ten years of experience. Almost all providers have practiced within the project site ED for their entire medical careers, with the average years of experience for physicians greater than ten years and five years for advanced practitioners.

The Institutional Review Board (IRB) requirements of both the project site and university were met to ensure compliance with ethical standards (Stommel & Wills, 2004). According to the Human Subjects Assessment of the Ohio State University, this project meets the criteria for a evidence-based practice project (see *Appendix F*). In accordance with university guidelines, the project is not considered formal research, therefore IRB submission was not required. However,

IRB submission was required by the project site because this was a student led initiative. It was determined that the project was exempt because it involved no more than minimal risks to human subjects and minimal data was collected with no identifying information (Office of Responsible Research Practices [ORRP], 2010). The process for assessment of human subject's protection within the project site involved multiples steps. They included:

1. Presentation of project's proposal to Nursing Research Council to gain support
2. Formal application and review by the IRB
3. Review by the Nursing Research Institute within the organization

After formal approval by the university and project site, the initial step in the project was to gather baseline data. The project coordinator gathered baseline information from existing de-identified medical imaging summary reports to determine the frequency of oral contrast use in a representative sample. Currently, the quantity of exams ordered with oral contrast is not monitored within the project site, however providers report frequent usage of oral contrast for the majority of abdominopelvic CT exams. Therefore, it was essential to collect baseline data to present to the stakeholder group to establish current practice patterns.

After baseline data was collected, a draft of the guideline was created using Microsoft Excel tools. Key clinical considerations for the appropriate use of oral contrast were included in the process as derived from the best available evidence and studied populations (included and excluded participants).

The project coordinator organized discussions with key stakeholders to review current process, share collected data, and draft of the guideline. The stakeholders for the project were nine interdisciplinary team members who currently lead specialty teams within the ED. These members volunteered based on expertise in their specialty as well as expressed interest in

improving ED throughput metrics and had no conflict of interest. Stakeholders are not only from various backgrounds and specialties, but also represented a wide range of years in clinical practice and educational preparation. Members of the ED nursing leadership team who are masters prepared were involved to provide input on guideline design and planning strategies for project implementation. Both the ED medical director for system as well as the project site were involved in the guideline development. Additionally, the lead radiologist for the medical imaging group and manager for medical imaging technologists were key stakeholders in guideline development.

As the guideline was being vetted with key stakeholders, it was important to come to a consensus on both the guideline itself and the implementation plan to secure a successful change in practice patterns. Keys to building consensus in the key stakeholder group were polling the general opinions of the stakeholders, listening effectively to suggestions and concerns, discussing ideas and differences openly, and coming to an agreement that everyone in the stakeholder group supported (Office of Personnel Management [OPM], n.d.). Using these strategies, the project coordinator was able to move the stakeholders through the “unfreezing” phase for changing current prescribing practices for oral contrast in abdominopelvic CTS.

### **Limitations and Barriers**

A limitation of the project was the time constraints associated with completing a student project within a designated time period. As a result, the project could not include the implementation phase.

Based on historical reactions to practice changes, the major barrier was emphasizing the need for implementing an evidence based practice change as part of routine clinical practice. Resistance was minimized by involving representatives from the ED providers, radiologists,

medical imaging and ED nursing leadership team in the guideline development. Preliminary consensus and support had already been gained with nursing and medical imaging leadership as well as providers prior to the start of the project, including both the ED medical directors and the chair of radiology.

### **Outcomes**

The primary measure for this project was qualitative in nature, a proposed oral contrast guideline based on best available evidence and expertise from stakeholder input. Individual patient data was not be collected for this QI project, but rather a single quantitative sample of total CTs ordered with associated contrast use as previously outlined. No identifying information was kept with the project records and all information was kept secured. Additional measures of the project included the financial implications for both the patient and organization on elimination of oral contrast in abdominopelvic CTs.

### **Evaluation of Guideline**

Evaluation of the evidence based practice project was key in determining the impact of the change as well as making adjustments to the practice strategy to ensure quality of care. A tool was developed using five point Likert scales and open-ended questions gather information about the guideline itself (structure, contents), feasibility of implementing, and foreseeable barriers to implementation (see *Appendix G*). As part of the stakeholder meeting, the evaluation form was administered to appropriately capture group feedback about the proposed guideline. The information from the evaluations was tabulated to ensure there is group consensus with moving forward with the guideline implementation.

### **Conclusion**

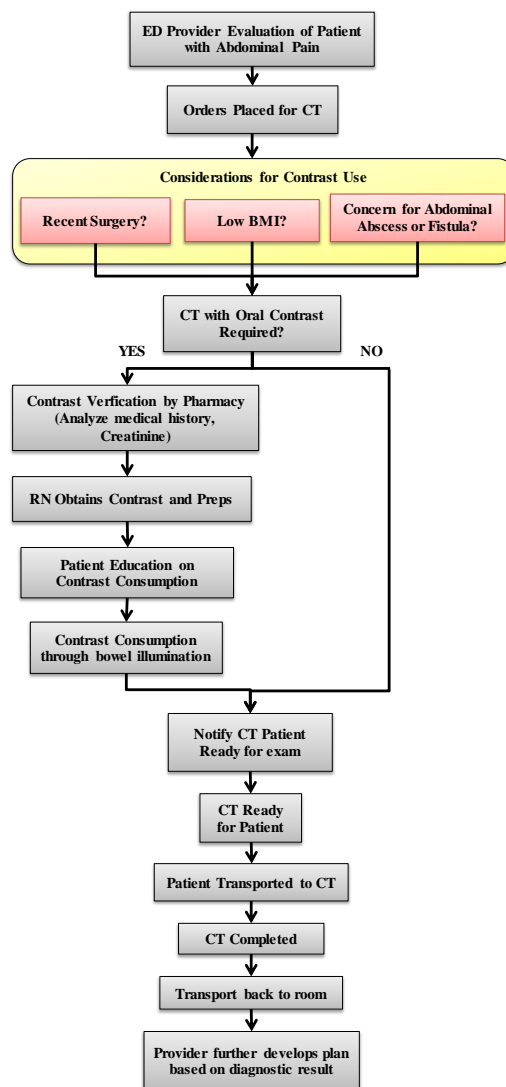
Using a methodical and interdisciplinary collaborative approach, the project coordinator led a group of key stakeholders in the development and adoption of guidelines for oral contrast use in abdominopelvic CTS. The final product of the project is a guideline to guide oral contrast use.

## Chapter IV: Findings

### Results

This project was successful in developing an evidence-based guideline through an interdisciplinary collaborative process. Initial steps in the project were to draft an evidence-based guideline reflecting the process and clinical considerations for oral contrast use. The draft of the evidence-based guideline for oral contrast use is outlined in **Figure 4.1** below.

■ **Figure 4.1.** Draft Evidence Based Guideline for Appropriate Use of Oral Contrast



*Figure 3.1.* Draft guideline to take to key stakeholder group that includes current evidence into the decision making process for oral contrast use in abdominopelvic CTs.



The “considerations for oral contrast use” were developed from the clinical pathologies studied in the literature. Patients having recent surgery, low BMI, or concern for abdominal abscess or fistula were excluded in research samples. These exclusions were assimilated within the algorithm as decision points to determine necessity of oral contrast use.

Early in the guideline development phase, radiology data combined with pharmacy dispensing data was used to determine the historical use of oral contrast within the emergency department. The number of monthly abdominopelvic CTs compared to the quantity of oral contrast dispensed is outlined below in Table 6.

Table 6

*Percentage of Abdominopelvic CTs with Oral Contrast Used*

	2015	2015	2015	2015	2016
	Sep	Oct	Nov	Dec	Jan
<b>Total CT orders</b>	<b>271</b>	<b>268</b>	<b>252</b>	<b>266</b>	<b>213</b>
<b>Oral Contrast Usage</b>	<b>169</b>	<b>158</b>	<b>149</b>	<b>140</b>	<b>126</b>
<b>% of CT Exams with Oral Contrast</b>	<b>62%</b>	<b>59%</b>	<b>59%</b>	<b>53%</b>	<b>59%</b>

The average monthly quantity of abdominopelvic CTs ordered with oral contrast in the emergency department was fifty-eight percent (Mission Health, personal communication, February 24, 2015). While the overall volume of CTs seemed lower than anticipated given the volume of patients presenting with abdominal pain, the quantity of CTs ordered with oral contrast was expected. This frequency data confirms the significance and potential impact of implementing an evidence-based guideline for oral contrast.

Cost information for the oral contrast and the drink that it is mixed in was obtained from pharmacy leadership. The organizational cost for the oral contrast per patient was \$7.55 in addition to \$2.71 for the drink the contrast is added to, for a total organizational cost of over ten dollars per patient. However, the cost to the patient was nearly ten times this amount

(approximately \$100) based on organizational mark-up to account for operating and administration costs. Elimination of routine oral contrast consumption may not only save the organization money, but also reduce the patients overall charge for their emergency department visit.

The baseline cost and oral contrast frequency data was summarized in preparation for the key stakeholder meeting. When the stakeholder meeting was scheduled, the evidence summary tables outlined in *Appendices A* and *C* in addition to the draft oral contrast guidelines (as previously outlined in *Figure 3.1*) were attached to the meeting invitation for review prior to the meeting. Additional stakeholders were added to the group based on feedback from nursing leaders, including the medical director for the general surgery department as well as the hospitalists. Addition of these two stakeholders was beneficial as they may be represented disciplines that may be impacted by the guideline. Meeting reminders were sent out 24 hours prior to the stakeholder meeting.

In addition to the project coordinator, Emergency department nursing leadership, medical imaging leadership, chair of radiology, and both the system and individual organization emergency department medical directors were present at the stakeholder meeting. Participants were provided with the baseline data described above and the draft oral contrast guideline along with the evaluation form (see *Appendix G*) designed to solicit feedback.

After review of the evidence, the key stakeholders determined to make the guidelines more prescriptive and specifically delineate disease pathologies instead of grouping into larger sections to lead clinicians to the appropriate use of the oral contrast. Bowel surgery was broken into both a historical and recent context. Because “low BMI” was not defined by a number in the literature, the stakeholders recommended changing the language to “lean body habitus”

which allows for clinical judgement and maintains consistency with some of the excluded populations in the literature. Additionally, criteria was added for a small subset of trauma patients who would benefit from oral contrast consumption. The group also recommended to change the guidelines from an algorithm format into a simple bulleted list for clarity. The title of guidelines was modified to specify the adult population (>18 years of age) as evidence does not exist in the pediatric population.

After this thoughtful discussion, stakeholders completed the “Stakeholder evaluation of oral contrast guidelines for abdominopelvic CT.” Eight evaluations were collected, one from each participant in the stakeholder meeting. Results of the evaluation are as follows based on Likert scale scoring:

- *Thoroughness of the guideline to cover key considerations* – 5 or “Very Good”
- *Applicability to clinical practice* – 5 or “Very good”
- *Ease of understanding for provider* – 4 or “Good”
- *Likelihood of changing practice* – 4 or “Good”

For the question asking if *Variables Missing* within the guideline, two narrative comments were made: “as discussed” and “to be addressed.” General comments received included:

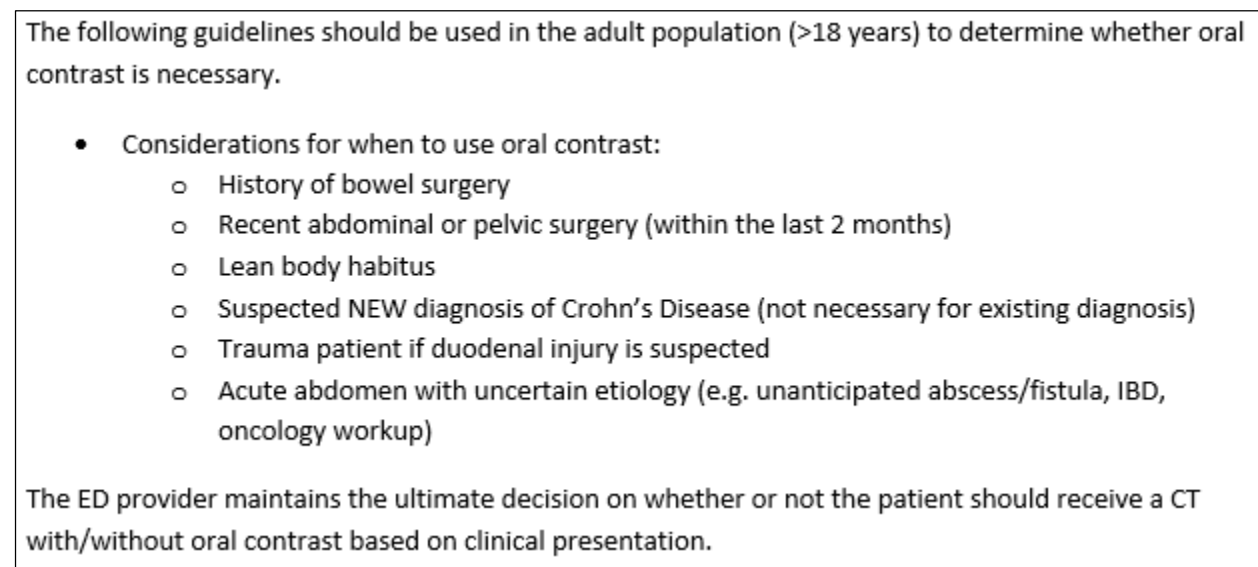
- *“This is really important”*
- *“This is great”*
- *“I’m excited about these”*
- *“Curious to see how providers will take to the guidelines”*

Information from the evaluations was addressed within the context of the stakeholder meeting discussion and all agreed that the final product would be beneficial to drive an evidence based practice change. After the meeting, the project coordinator made guideline revisions and sent to

the stakeholder group. This information was shared with the larger group of radiologists to gain consensus and providers were given one week to respond with changes.

Follow-up items were completed as outlined after the stakeholder meeting. Very few changes were recommended and a final format was sent to stakeholder group as outlined in **Figure 4.2** below.

■ **Figure 4.2.** Adult Oral Contrast Guidelines for Abdominopelvic CT



*Figure 4.2.* Final evidence-based guideline to guide the decision making process for oral contrast use in abdominopelvic CTs performed in the emergency department.

The final guideline was reviewed to ensure consistency with IOM recommendations for standards for clinical practice guidelines (IOM, 2011).

### Discussion

The mission of the project site is “to get each patient to the desired outcome, first without harm, also without waste and with an exceptional experience for the patient and family” (Mission Health, 2014, para. 2). Development of the evidence-based guidelines for the use of oral contrast in abdominopelvic CTs upheld the mission of the organization. Patients will “achieve their desired outcome” of understanding the underlying etiology of their pain:

- “without harm” of potential oral contrast side effects and potential for repeat imaging
- “without waste” of time and monetary resources
- “improving the patient experience” through elimination of drinking contrast and the additional time spent in the emergency department for evaluation. (Mission Health, 2016)

The engagement of the interdisciplinary stakeholders was instrumental to successful project completion. The ED providers expressed a desire to change to an evidence-based model for contrast administration based on anticipated benefits to improving ED length of stay and radiology providers supported this endeavor and were thorough in their review and input into the guidelines. ED nursing leadership representation for the discussion was key as they were able to represent any downstream effects these changes may have on nursing associated workflows.

Any interdisciplinary effort that requires a physical meeting to facilitate dialogue is often a challenge with schedules. This held true in this project. The participants who were unable to attend the stakeholder meeting in person were individually contacted and given the opportunity to provide feedback and remained fully supportive of the practice change.

### **Conclusion**

This evidence based practice project had three main objectives: To develop an evidence based guideline for use of oral contrast in abdominopelvic CTs, to increase the efficiency in the diagnostic process of patients presenting with abdominal pain in the ED and to demonstrate the role of the DNP in designing and implementing an interdisciplinary, evidence-based practice change. All objectives were met through collaboration with key stakeholders in developing a scholarly and collegial relationship to share available evidence and construct a novel practice

change guideline. The project was successful and key stakeholders were engaged and enthusiastic about the practice change and the potential impact.

## **Chapter V**

### **Project Summary**

This project demonstrated successful development of an evidence-based guideline for oral contrast use in abdominopelvic CT through the efforts of the DNP in leading an interdisciplinary collaborative change process. This evidence-based practice change serves as a prime example of a DNP led practice change, incorporating evidence to improve quality of care and patient outcomes. Historical use of oral contrast in abdominopelvic CTs within the project site was not grounded in current evidence, therefore the evidence-based guidelines for oral contrast will facilitate process improvement to potential improve length of stay metrics. A thorough review of the literature was conducted and a draft of evidence-based guidelines for the use of oral contrast was developed. A group of key stakeholders met to review baseline data and the draft guidelines. Changes were made to the guidelines based on stakeholder feedback and an implementation plan was developed. Implementation of the final guidelines and dissemination across specialties will occur as a follow up effort within the project site.

### **Limitations**

A major limitation of this project was the potential resistance to change based on existing provider attitudes that the current nondiscretionary use of oral contrast is in line with best practice. A second limitation of this project was the isolation of this project to the emergency department; consequently the guideline may not have generalizability to the inpatient populations based on complexities and uniqueness of their health conditions.

### **Implications for Nursing Practice and the DNP Essentials**

The Doctor of Nursing Practice (DNP) leader in today's healthcare setting has the expert knowledge and skill set to champion evidence-based practice changes that streamline inefficient

system processes and improve overall patient care. A key objective of this project was to demonstrate the role of the DNP as a leader in developing an interdisciplinary evidence-based practice change guideline. The role of the DNP leader to drive interdisciplinary evidence-based changes is a newer concept. This project has demonstrated the effectiveness of this role in supporting organizational strategies to improve the quality of care.

This evidence based practice project demonstrated many of the DNP essentials set for by the American Association of Colleges of Nursing (AACN, 2006). DNP Essential I, scientific underpinnings for practice, was demonstrated through the development and evaluation of new practice approaches by using science-based theories and concepts to describe strategies to alleviate healthcare delivery phenomena such as prolonged ED length of stay for abdominal pain patients. Organizational and systems leadership for quality improvement and systems thinking, DNP Essential II, was illustrated through the development of a care delivery approach that meets current and future needs of patient populations based on organizational and economic sciences to decrease ED length of stay by guiding an interdisciplinary team through the change process. DNP Essential III, clinical scholarship and analytical methods for evidence-based practice was exemplified through the analysis and synthesis of the evidence to provide support for the design, direction, and evaluation of this evidence-based project to promote safe, timely, effective, and efficient patient care within the ED. Essential VI, interprofessional collaboration for improving patient and population health outcomes, was the center of this project and involved leading an interprofessional team to contribute to the design and implementation of an evidenced based guideline for the use of oral contrast in abdominopelvic CTs. And finally, DNP Essential VIII, advanced nursing practice, was illustrated through demonstration of advanced levels of clinical judgement, systems thinking, and accountability in designing, delivering, and evaluating



evidence-based care to improve patient outcomes through the implementation of the practice project (American Association of Colleges of Nursing [AACN], 2006). Practicing in accordance with the DNP Essentials, the project coordinator acted change agent to design an evidence-based practice guideline intended to guide abdominopelvic CT processes, ultimately designing a practice strategy to enhance ED efficiency.

### **Plans for Dissemination**

Dissemination of evidence-based practice is imperative to improving quality in the overall care of patients. Project findings will be shared at both the university and project site level. Within the university, a public presentation will occur with nursing colleagues and faculty. The evidence-based practice project will also be shared within the project site at multiple levels, both unit and organizational. A follow up presentation to the Nursing Research Council within the project site will be given to share results and discuss future goals. Additional plans for dissemination will include publishing results and/or public presentations in professional nursing arenas.

### **Conclusion**

The development of an evidence-based guideline to guide oral contrast use for patients receiving abdominopelvic CTs in the emergency department is a single strategy for increasing efficiencies within the complex system. The next steps include implementation of the guideline with a possible research approach to demonstrate outcomes in terms of ED efficiency and length of stay.

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## Appendix A

Table 1

*Evaluation of Literature for Oral Contrast in Abdominopelvic CTs Impact on ED Efficiency*

Citation	Design/Method	Sample/Setting	Major Variables Studied and Their Definitions	Outcome Measurement	Data Analysis	Findings	Level of Evidence
Hopkins, C., Madsen, T., Foy, Z., Reina, M., & Barton, E. (November 2012). Does limiting oral contrast decrease emergency department length of stay? <i>Western Journal of Emergency Medicine</i> , 8 (5), pp. 383-387.	Retrospective Case Controlled	211 patient undergoing both OC and IVC compared to 184 IVC only for ABCT at a large academic emergency department over a 4 month period  **Included Patients with Clinical History & physical exam suggestive of appendicitis, diverticulitis, SBO, or intra-abdominal free air.  **Excluded post-operative & underlying medical issues	IV1= OC DV1=LOS DV2= TAT	LOS, TAT	LOS shorter for patients imaged IVC only (4:35 hrs vs. 6:39 hrs, $p < 0.0001$ ). Shorter LOS in patients discharged to home, inpatients to OR. Median TAT 126 minutes for studies with OC & IVC and 52 min for IVC only. Rescan rates comparable between groups.	IVC only ABCT prep for select ED patients with acute abdominal pain significantly decreased LOS.	IV
Huynh, L. N., Coughlin, B. F., Wolfe, J., Blank, F., Lee, S. Y., & Smithline, H. A. (2004). Patient encounter time intervals in the evaluation of emergency department patients requiring abdominopelvic CT: Oral contrast versus no contrast. <i>Emergency Radiology</i> , 10, 310-313.	Retrospective cohort study	All ABCT scans at a high-volume regional medical center over a 30 day period, N=258  **Excluded <16 years of age, pregnancy, and acute major trauma	IV1= IVC only IV2 = OC DV1 = Door to doc DV2=Provider eval to CT order DV3 = TAT DV4 = LOS	Door to Doc Doc to Order TAT LOS	Door to Doc (IVC 57 min, OC 84 min, $P<0.001$ ); Doc to order (IVC 35 min, OC 63 min, $P<0.01$ ); TAT (IVC 104 min, OC 172 min, $P<0.001$ ); LOS (IVC 358 min, OC 599 min, $P<0.001$ ).	Significant time interval differences between OC and IVC exams during ED visits for adults with abdominal pain.	IV

Kepner, A. M., Bacasnot, J. V., & Stahlman, B. A. (2012). Intravenous contrast alone vs intravenous and oral contrast computed tomography for the diagnosis of appendicitis in adult ED patients. American Journal of Emergency Medicine, 30, 1765-1773.	Prospective Randomized study	244 randomized adult patients in community teaching ED with 75000 annual visits  **Included >18 years of age and signs/symptoms suggestive of appendicitis	IV1=IVC IV2=IVC and OC DV1=Diagnosis of appendicitis DV2=Time from Triage to operating room DV3=Time from Triage to ED disposition DV4=Oral contrast reaching cecum	Diagnosis of appendicitis Time from triage to operating room Time from triage to ED disposition Oral contrast reaching cecum BMI	Both IVC (n = 114) and OC/IVC (n = 113) scans 100% Sens (95% CI 89.3-100 and 87.4-100, resp) and NPV (95% CI, 93.7-100 and 93.9-100, resp) for appendicitis. Spec of IV and IV/OC scans was 98.6 and 94.9 (95% CI, 91.6-99.9 and 86.9-98.4, resp), resp, with PPVs of 97.6 and 89.5 (95% CI, 85.9-99.9 and 74.2-96.6). Median times to ED disposition and OR were 1 hr 31 mins (P < .0001) & 1hr 10 min (P = .089) faster for the IV group, resp. Patients with negative IV scans were discharged 2 hours faster (P = .001).	IVC comparable diagnostic performance to scans performed with IVC/OC. Patients receiving IVC only are discharged from the ED faster.	II
Levenson, R. B., Camacho, M. A., Horn, E., Saghir, A., McGillicuddy, D., & Sanchez, L. D. (2012). Elimination routine oral contrast use for CT in the emergency department: Impact on patient throughput and diagnosis. Emergency Radiology, 19, 513-517.	Retrospective QA Eval	2001 ED patients at Level 1 trauma center with 53000 ED visits per year who received ABCT during 2 separate 2 month periods  **Excluded known history of inflammatory bowel disease, gastrointestinal tract-altering surgery, or lean body habitus	IV1= OC DV1=LOC DV2=TAT	LOS TAT 72 hour ED return Repeat imaging	607 preintervention & 611 post-intervention eligible for OC were included. 95 % received OC prior to intervention & 42 % after. After intervention, mean LOS among OC eligible patients decreased by 97 min, P<0.001. Mean TAT decreased by 66 min, P<0.001. No patient with CT negative for acute findings had subsequent ABCT imaging within 72 h that led to a change in diagnosis.	Eliminating routine OC use for ABCT in ED may be successful in decreasing LOS and TAT without demonstrated compromise in acute patient diagnosis.	VI
Razavi, S. A., Johnson, J., Kassir, M. T., & Applegate, K. E. (2014). The impact of introducing a no oral contrast abdominopelvic CT examination (NOCAPE) pathway on radiology turnaround times, emergency department length of stay, and patient	Observational study	6409 ED patients with abdominal pain requiring ABCTs over 12 month period at 2 urban hospitals  **Excluded patients with recent gastrointestinal surgery (2 wks) or clinical concern for abdominal fistulae or abscess	IV1= OC DV1=TAT DV2=LOS DV3=Admission to hospital DV4=Return to CT rats DV5=Return to ED	TAT LOS Patient safety metrics (admission, recall, bounce back rates)	The IVC only reduced median TAT by 32 min (22.9 %) compared to IVC and OC (P<0.001).Median TAT was 2.9 h in IVC only patients and 3.5 h in OC patients, a 36-min (17.1 %) reduction (P<0.001). IVC only reduced LOS by a median of 43 min (8.8 %) compared to OC CTs (8.2 vs 7.5 h)	IVC only associated with decreased TAT & LOS metrics. Implementation in ED setting is safe and positively impacts both radiology and emergency medicine workflow.	IV

safety. Emergency Radiology, 21, 605-613.					(P=0.003). Recall and bounce back rates were 3.2 %, and one patient had change in impression after oral contrast CT was repeated.		
Schurr, J., Chu, G., & Sucov, A. (2010). Effect of oral contrast for abdominal computed tomography on emergency department length of stay. <i>Emergency Radiology</i> , 17, pp. 267-273.	Retrospective cohort study	1806 adult patient requiring ABCT over 13 week period at academic medical center	IV1=OC DV1=LOS DV2= TAT	TAT LOS	OC usage decreased from 42.5% to 12.2% (difference 30.3%, 95% CI 38.7% to 46.3%). No change in LOS among all ED visits. ED visits where an ABCT was performed, median TAT decreased by 27 min and median LOS decreased by 30 min.	Not routinely requiring OC for ABCT in the ED is associated with a half-hour reduction in LOS among all patients undergoing ABCT.	IV

**LEGEND**

ABCT= Abdominopelvic CT; OC= Oral Contrast; IVC= IV Contrast; N/V=Patient reported Nausea/Vomiting; TAT = CT Turnaround time (Order to Complete); LOS = ED Length of Stay; OCU = Percent of Oral Contrast Abdominopelvic CTs ordered; BMI= Body Mass Index; CI=Confidence Interval; NPV=Negative Predictive Value; PPV=Positive Predictive Value; Sens=Sensitivity; Spec=Specificity; Resp=Respectively; QI=Quality Assurance

*Appendix B*

Table 2

*Synthesis of Literature on Oral Contrast Use and Efficiency of Time in ED*

	1 <sup>a</sup>	2	3	4	5	6
<b>TAT</b>	NE	↓ <sup>c</sup>	↓ <sup>b</sup>	↓ <sup>b</sup>	↓ <sup>b</sup>	↓ <sup>c</sup>
<b>LOS</b>	↓ <sup>b</sup>	↓ <sup>b</sup>	↓ <sup>b</sup>	↓	↓	NE
<b>OCU</b>	NE	NE	NE	NE	↓ <sup>b</sup>	NE

**LEGEND**

1=Kepner, AM, et al.; 2=Hopkins, C et al.; 3=Huynh, LN, et al.; 4=Razavi, SA, et al.; 5=Schurr, J, et al.; 6=Levenson, RB, et al.

TAT = CT Turnaround time (Order to Complete); LOS = ED Length of Stay; OCU = Percent of Oral Contrast Abdominopelvic CTs ordered; NE=Not Evaluated; NR=Not Reported

<sup>a</sup>Higher-level evidence; <sup>b</sup>Statistically significant findings; <sup>c</sup>Statistical significant not reported

## Appendix C

Table 3

*Evaluation of Literature for Equivocal CT Results Without Oral Contrast*

Citation	Design/Method	Sample/Setting	Major Variables Studied and Their Definitions	Outcome Measurement	Data Analysis	Findings	Level of Evidence
Allen, T. L., Mueller, M. T., Bonk, R. T., Harker, C. P., Duffy, O. H., & Stevens, M. H. (2004, February). Computed tomographic scanning without oral contrast solution for blunt bowel and mesenteric injuries in abdominal trauma. <i>The Journal of Trauma Injury, Infection, and Critical Care</i> , 56, 314-322.	Prospective cohort	500 consecutive adult blunt trauma patients receiving ABCT over 17 month period	IV1= OC IV2 = IVC DV1 = BBMI Identification	CT imaging detection of BBMI  Repeated CT	Initial IVC detected 19 of 20 BBMI with a missed one duodenal perforation. 2 patients with false-positive interpretation of initial CT for bowel injury. Sens of IVC for BBMI=95.0%, Spec=99.6%	IVC for ABCT for detection of BBMI compares favorably with OC	IV
Anderson, B. A., Salem, L., & Flum, D. R. (2005). A systematic review of whether oral contrast is necessary for the computed tomography diagnosis of appendicitis in adults. <i>The American Journal of Surgery</i> , 190, 474-478.	Systematic Review	23 studies, including 3474 patients >16 years of age undergoing CT scanning for suspected appendicitis	IV1= OC IV2 = IVC IV3 = OC & IVC DV1 = CT Result	Quality of CT exam NV	IVC & OC scans similar results (Sens, 95% vs. 92% [not statistically significant]; (NPV) or better (Spec, 97% vs. 94%; PPV, 97% vs. 89%; accuracy, 96% vs. 92%; P < .0001) than with OC	IVC only techniques to diagnose appendicitis showed equivalent or better diagnostic performance compared with OC. Patients preference due to no contrast consumption while N/V or require IV placement	V
Anderson, S., Rhea, J., Milch, H., Ozonoff, Z., Lucey, B. & Soto, J. (2010). Influence of body habitus and use of oral contrast on reader confidence in patients with suspected acute appendicitis using 64 MDCT. <i>Emergency Radiology</i> , 17, pp. 445-453.	Randomized controlled trial	303 adult patients with acute abdominal pain and clinical suspicion of appendicitis, diverticulitis, or small bowel obstruction	IV1= OC IV2 = IVC IV3 = OC & IVC DV1 = Quality of Scan	Reader confidence in diagnosing appendicitis  Quality of CT scan	Statistically significant difference in confidence based on BMI for reader 2, group 1 in diagnosing appendicitis. No further statistically significant differences in reader confidence for diagnosing appendicitis based on BMI or intra-abdominal fat identified. No influence of BMI or intraabdominal fat on appendiceal	No statistically significant differences in confidence between the two CT protocol groups for the diagnosis of appendicitis were seen for any of the three readers. Neither BMI nor intra-abdominal fat were seen to influence appendiceal visualization.	II



					visualization. Increasing BMI was seen to improve reader confidence for 1 of 3 readers in patients that received OC and IVC. No further effects of BMI or intraabdominal fat on confidence in diagnosing or excluding appendicitis were seen.		
Buttigieg, E. L., Grima, K. B., Cortis, K., Soler, S. G., & Zarb, F. (2014). An evaluation of the use of oral contrast media in abdominopelvic CT. <i>European Society of Radiology</i> , 24, 2936-2944. <a href="http://dx.doi.org/10.1007/s00330-014-3285-8">http://dx.doi.org/10.1007/s00330-014-3285-8</a>	Prospective Randomized Controlled Trial	46 adult patients receiving ABCT as follow-up for oncological indications who had previous ABCT with OC	IV1= Positive Contrast IV2 = Neutral Contrast IV3 = Negative Contrast DV1 = Quality of Scan	Quality of CT Scan  Confidence of Radiologists in Interpreting Film (AUCVGC)	No statistically significant differences in the AUCVGC values from the 0.5 value were recorded, indicating similar image quality between the two protocols. No statistically significant differences in the AUCVGC values with the 0.5 value were found between the two protocol comparisons with regards to artefact analysis	All three OCM protocols provided similar image quality for follow-up abdominopelvic CT for general oncological indications.	II
Glauser, J., Siff, J., & Emerman, C. (2014, September). Emergency department experience with non-oral contrast computed tomography in the evaluation of patients for appendicitis. <i>Journal of Patient Satisfaction</i> , 10(3), 154-158.	QI	311 ABCT scans over 7 month period for nontraumatic abdominal pain evaluation	IV1= OC IV2 = IVC IV3 = OC & IVC DV1 = Quality of Scan	Accurate diagnosis of appendicitis 30 day follow-up	No cases of appendicitis were missed. No patients (0%; 95% CI, 0% Y1.2%) required a repeat OC ABCT as part of the workup. On 30-day follow-up by chart review, no (0%; 95% CI, 0% Y1.2%) significant surgical problems were identified, and no cases of missed appendicitis were identified.	ABCT without the use of OC is accurate to allow for appropriate decision making by emergency physicians and general surgeons.	VI
Hill, B. C., Johnson, S. C., Owens, E. K., Gerber, J. L., & Senagore, A. J. (2010). CT scan for suspected acute abdominal process: Impact of combinations of IV, oral, and rectal contrast. <i>World Journal of Surgery</i> , 34, 699-703.	Retrospective Cohort	661 patients of 19 month period requiring ABCT to evaluate for acute abdominal process	IV1= OC IV2 = IVC IV3 = OC & IVC DV1 = Quality of Scan	Combination of contrast used CT diagnosis Time from CT scan to intervention Intervention type Actual diagnosis	Use of IVC was found in 54.2% of ABCT and was correct in 92.5% of cases. IVC & OC used in 22.2% of CT scans and was 94.6% correct. Unenhanced Imaging performed in 16.2% and was correct in 92.5%. OC was used in 7.0% and was 93.5%	Regardless of the combination of contrast used, correct diagnosis was made 93% of the time. The combination of IVC & OC led to an accurate diagnosis 94.6% of the time. No significant difference in	IV

					correct. There was no significant difference in the ability to correctly diagnose a suspected acute abdominal process when enhanced CT imaging was compared to unenhanced (p>0.05).	the accuracy of CT diagnosis when any combination of contrast was compared to CTs performed without contrast.	
Hlibczuk, V., Dattaro, J., Jin, Z., Falzon, L., & Brown, M. (2010). Diagnostic accuracy of noncontrast computed tomography for appendicitis in adults: A systematic review. <i>Annals of Emergency Medicine</i> , 55, pp. 51-59.	Systematic Review	7 studies of 1060 adult patients to evaluate for appendicitis	IV1= OC IV2 = IVC IV3 = OC & IVC DV1 = CT Result	Quality of CT exam	Six of the 7 studies in this systematic review included radiologists as investigators and all support the use of non-contrast CT scans for the diagnosis of appendicitis. CT cannot exclude appendicitis with 100% certainty & must be interpreted within clinical context. Depending on patient's condition & circumstances, clinical judgment must be used when deciding to perform IVC only or OC/IVC for suspected appendicitis. Our 7.3% summary estimate for the false-negative rate is within the range of false-negative rates (3% to 17%) reported in a systematic review that included various CT contrast protocols.	Diagnostic accuracy of noncontrast CT for the diagnosis of acute appendicitis in the adult population to be adequate for clinical decision-making in the ED setting	V
Holmes, J. F., Offerman, S. R., Chang, C. H., Randel, B. E., Hahn, D. D., Frankovsky, M. J., & Wisner, D. H. (2004, January). Performance of helical computed tomography without oral contrast for the detection of gastrointestinal injuries. <i>Annals of Emergency Medicine</i> , 43(1), 120-128.	Retrospective cohort	6052 patients over five year period at Level 1 trauma center requiring ABCT to evaluate for gastrointestinal injury	IV1=IVC DV2=Quality scan	Abdominal CT scan result	ABCT result was abnormal in 91 (86%; 95% confidence interval [CI] 78% to 92%) of the 106 patients with gastrointestinal injuries and revealed findings suggestive of gastrointestinal injury in 81 (76%; 95% CI 67% to 84%) patients. ABCT demonstrated findings suggestive of	Helical ABCT without OC identified nearly three fourths of patients with blunt gastrointestinal injuries who were selected for ABCT. Sensitivity of this diagnostic test improves in the subset of patients with major gastrointestinal injuries.	IV

					gastrointestinal injury in 58 of 64 (91%; 95% CI 81% to 96%) patients with major gastrointestinal injuries. 238 (4.0%) patients had findings suspicious for gastrointestinal injuries on ABCT, but gastrointestinal injury was never confirmed.		
Kammerer, S., Hoink, A. J., Wessling, J., Heinzow, H., Koch, R., Schuelke, C., Buerke, B. (2015). Abdominal and pelvic CT: is positive enteric contrast still necessary? Results of a retrospective observational study. <i>European Society of Radiology</i> , 25, 669-678.	Retrospective randomized controlled trial	2008 patients requiring ABCT over 15 month period	IV1=Positive OCM IV2=Neutral OCM (water) IV3=Negative OCM DV1=Quality of scan	Quality of CT image	In most cases, making a diagnosis of abdominal pathologies was not affected by the enteric contrast agent in any ABCT. Compared to ABCT without enteric contrast, those with positive or neutral enteric contrast revealed a statistically significant improvement in making a diagnosis. The probability of a diagnostic improvement from the use of neutral oral contrast is increased by an odds ratio of 4.63 (95 % CI 1.35–15.87, p=0.7470). Using positive contrast, the odds of an improvement are about 4.66 times higher (1.36–15.97, p=0.0144), compared with no oral contrast.	Compared to positive enteric contrast, neutral contrast ensures at least equivalent delineation of the bowel and a similar detection rate for intestinal pathologies across almost all clinical indications. The absence of enteric contrast often noticeably impairs delineation. In selected clinical scenarios (e.g. bleeding), positive enteric contrast is inferior to neutral enteric contrast and can therefore be replaced by neutral oral contrast, thereby enhancing diagnostic reliability. However, positive enteric contrast should continue to be used in patients with suspected bowel leakage.	II

Kepner, A. M., Bacasnot, J. V., & Stahlman, B. A. (2012). Intravenous contrast alone vs intravenous and oral contrast computed tomography for the diagnosis of appendicitis in adult ED patients. <i>American Journal of Emergency Medicine</i> , 30, 1765-1773.	Prospective randomized study	227 patients requiring ABCT to evaluate for appendicitis	IV1= OC IV2 = IVC IV3 = OC & IVC DV1 = Quality of Scan	Quality of CT image Time to ED disposition	Both IVC (n = 114) and IVC & OC (n = 113) scans had 100% sensitivity (95% CI, 89.3-100 and 87.4-100, resp) and NPPV (95% CI, 93.7-100 and 93.9-100, resp) for appendicitis. Spec of IV and IVO scans was 98.6 and 94.9 (95% CI, 91.6-99.9 and 86.9-98.4, resp), resp, with PPV of 97.6 and 89.5 (95% CI, 85.9-99.9 and 74.2-96.6). Median times to ED disposition and OR were 1 hour and 31 minutes (P < .0001) and 1 hour and 10 minutes (P = .089) faster for the IVC, resp. Patients with negative IV scans were discharged nearly 2 hours faster (P = .001).	ABCT with IVC alone have comparable diagnostic performance to IV+OC scans for appendicitis in adults. Patients receiving IVC are discharged from the ED faster than those receiving IV+OC scans.	II
Laituri, C. A., Fraser, J. D., Aguayo, P., Fike, F. B., Garey, C. L., Sharp, S. W., ... St. Peter, S. D. (2011). The lack of efficacy for oral contrast in the diagnosis of appendicitis by computed tomography. <i>Journal of Surgical Research</i> , 170, 100-103.	Retrospective cohort	1561 patients requiring ABCT for appendicitis over 4 year period	IV1= OC IV2 = IVC IV3 = OC & IVC DV1 = Appendicitis diagnosis DV2=Contrast to ABCT time DV3=Nausea	Quality of CT image Contrast location Associated nausea	652 (41.8%) were diagnosed with appendicitis. Contrast was identified at least to the level of the terminal ileum in 72.4% of the entire population. The contrast was present in 76.2% of the non-appendicitis patients and 67.0% of the appendicitis patients (P = 0.01). Mean time from oral contrast administration to CT imaging was 105.5 min, which was longer in patients with appendicitis (112.2 min) compared with nonappendicitis patients (100.9 min) (P = 0.01). Emesis of the contrast occurred in 19.3% of those with appendicitis and 12.9% of those without appendicitis (P=0.001).	Nearly 30% of patients receiving oralcontrast for the CT diagnosis of appendicitis do not have contrast in the point of interest at the expense of emesis, nasogastric tube placement, and diagnostic delay. These detriments are amplified in patients who have appendicitis. Further, there appears to be no diagnostic compromise in those without contrast in the terminal ileum.	IV

					Nasogastric tubes were placed in 5.8% of those with appendicitis and 5.1% of those without (P=0.37). Appendicitis was confirmed at operation in 94.3% of those with contrast in the area and 94.4% of those without (P = 1.0). Pathology confirmed appendicitis in 90.6% of those with contrast in the area and 94.0% of those without (P=0.17)		
Latifi, A., Labruto, F., Kaiser, S., Ullberg, U., Sundin, A., & Torkzad, M. (March/April 2011). Does enteral contrast increase the accuracy of appendicitis diagnosis? <i>Radiologic Technology</i> , 82(4), pp. 297-299.	Retrospective cohort	246 patients >15 years of age with suspected appendicitis who had ABCT over 2 year period	IV1= OC IV2 = IVC IV3 = OC & IVC DV1 = Appendicitis diagnosis	Use of contrast agents Route of administration Quality of CT	Diagnosis of appendicitis was found in 22.6% of patients in group OC; 29.7% of patients with rectal contrast; 38% of patients without enteric contrast; and 30.5% of patients with both oral and rectal. Diagnosis of appendicitis was found in 75.6% of patients in OC; 68.9% of patients with rectal contrast; 57.1% of patients without enteric contrast; and 69.4% of patients with oral and rectal.	Study shows that the accuracy for diagnosis of appendicitis by ABCT is high regardless of enteral contrast use. Therefore, further use of enteral contrast agents for CT diagnosis of appendicitis in adults cannot be recommended.	IV
Lee, C. H., Haaland, B., Earnest, A., & Tan, C. H. (2013). Use of positive oral contrast agents in abdominopelvic computed tomography for blunt abdominal injury: Meta-analysis and systematic review. <i>European Society of Radiology</i> , 23, 2513-2521.	Systematic Review	Review of 32 studies evaluating positive oral contrast agents in ABCT	IV1=Positive OCM IV2=Neutral OCM (water) IV3=Negative OCM DV1=Quality of scan	Accuracy of ABCT	32 studies were divided into two groups. Group 1 comprised 15 studies comparing CT with positive and without oral contrast agents. Meta-analysis of five studies from group 1 provided no difference in sens (P=0.578) or spec between CT with positive or without oral contrast agents. Weak evidence that the spec of CT performed without OC was slightly lower than CT with a positive OC [99.5 % (99 % -	No difference in the accuracy of CT with or without OC. No difference in the accuracy of CT with Gastrografin or water. Omission of OC, utilizing neutral or negative OC agent saves time, costs and decreases risk of aspiration.	V

					99.7 %) vs. 99.9 % (99.6 %-100 %) resp; P=0.055]. Group 2 comprised 17 studies comparing CT with positive and neutral or negative oral contrast agents. Systematic review of 12 studies from group 2 indicated that neutral or negativeoral contrasts were as effective as positive oral contrast agents for bowel visualisation.		
Lee, S. Y., Coughlin, B., Wolfe, J. M., Polino, J., Blank, F. S., & Smithline, H. A. (2006). Prospective comparison of helical CT of the abdomen and pelvis without and with oral contrast in assessing acute abdominal pain in adult emergency department patients. <i>Emergency Radiology</i> , 12, 150-157.	Prospective cohort	Convenience sample of 118 patients over 13 month period with abdominal pain undergoing ABCT 90 minutes apart (first without OC, then with OC) read by 2 difference radiologists  **Excluded trauma, renal colic, pregnancy	IV1= OC IV2 = IVC IV3 = OC & IVC DV1 = diagnosis	Quality of CT Radiologist discrepancy	21 patients that had significant disagreement of interpretations between no contrast CT and OC resulting in a simple agreement of 79% (95% CI: 70–87%). For specific radiologic parameters, agreement ranged from 77 to 100%. A post hoc agreement analysis was subsequently performed by 2 radiologists and only 5 paired scans were identified as discordant between the no contrast and OC. Only 1 of these patients did both radiologists agree that there was a definite discordant result between the 2 studies. A final unblinded consensus review demonstrated that much of the disagreement between the interpretations was related to interobserver variation.	Significant portion of the discordance was attributable to interobserver variability. This data suggests that unenhanced CT should be considered in adult ED patients presenting with acute abdominal pain.	IV
Stuhlfaut, J. W., Soto, J. A., Lucey, B. C., Ulrich, A., Rathlev, N. K., Burke, P. A., & Hirsch, E. F. (2004, December). Blunt abdominal trauma: Performance of CT	Retrospective cohort	1082 patients over 2 year period who had ABCT without oral contrast in which CT	IV1= OC IV2 = IVC DV1 = diagnosis	Quality of CT scan	CT findings were no intraabdominal injury (n=932), solid organ injury only (n=102), free	Multi-detector row CT without oral contrast material is adequate	IV

without oral contrast material. <i>Radiology</i> , 689-694.		results compared to laparotomy reports and hospital course			fluid only (n=34), and suspected BBMI (n=14). CT findings in patients suspected of having BBMI were pneumoperitoneum with other secondary findings (n=4), mesenteric hematoma and bowel wall abnormality (n=2), mesenteric hematoma only (n=4), and bowel wall thickening only (n=4). In 11 patients, BBMI was proved surgically. Study included 1066 true-negative, nine true-positive, two false-negative, and five false-positive results. Based on these data, sens was 82% (95% CI: 52%, 95%), spec was 99% (95% CI: 98%, 99%), PPV was 64% (95% CI: 39%, 83%), and NPV was 99% (95% CI: 98%, 99%) for depiction of BBMI.	for depiction of bowel and mesenteric injuries that require surgical repair.	
Wolfe, J., Smithline, H., Lee, S., Coughlin, B., Polino, J., & Blank, F. (2006). The impact of body mass index on concordance in the interpretation of matched noncontrast and contrast abdominal pelvic computed tomographic scans in ED patients with nontraumatic abdominal pain. <i>American Journal of Emergency Medicine</i> , 24, pp. 144-148.	Prospective observational trial	Convenience sample of 100 patients undergoing ABCT over 1 year period	IV1= OC IV2 = IVC DV1 = BMI DV2=Quality of CT DV3=Waist Circumference	Agreement between interpretation of no contrast and OC ABCT	63 of the patients had an abnormal CT. The abdominal pathologies identified were varied and represented pathology from throughout the abdomen. 21 (95% CI, 13%-30%) had clinically significant discordant interpretations between OC and no contrast. The most frequent CT interpretations for these patients were appendicitis (n=7), diverticulitis (n=5), gynecologic mass (n=3), and other (n=6). Regression analyses did not demonstrate a relationship	Increased intraabdominal fat may not aid in the interpretation of a noncontrasted abdominal CT scan. Did not find association between BMI, sex, or waist circumference and concordance of radiologists' interpretation of noncontrast and oral contrast abdominal pelvic CT scans in ED patients.	III

					between agreement and BMI (odds ratio, 1.0; 95% CI, 0.9-1.1) with sex as an IV nor between agreement and waist circumference (odds ratio, 1.0; 95% CI, 0.9-1.1) with sex as an IV.		
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**LEGEND**

IV=Independence Variable; DV= Dependent Variable; ABCT= Abdominopelvic CT; OC= Oral Contrast; IVC= IV Contrast; OCM=Oral Contrast Media; N/V=Patient reported Nausea/Vomiting; BBMI= Blunt Bowel and Mesenteric Injuries; TAT = CT Turnaround time (Order to Complete); LOS = ED Length of Stay; OCU = Percent of Oral Contrast Abdominopelvic CTs ordered; BMI= Body Mass Index; CI=Confidence Interval; NPV=Negative Predictive Value; PPV=Positive Predictive Value; Sens=Sensitivity; Spec=Specificity; Resp=Respectively; QI=Quality Improvement study



## Appendix D

Table 4

*Synthesis of Literature on Equivocal CT Results Without Oral Contrast*

	1 <sup>a</sup>	2 <sup>a</sup>	3 <sup>a</sup>	4 <sup>a</sup>	5	6	7	8	9	10	11	12	13	14	15	16
<b>OC &amp; IVC vs IVC only</b>	=	= <sup>c</sup>	=*	=	= <sup>c</sup>	= <sup>c</sup>	= <sup>b</sup>	= <sup>c</sup>	= <sup>b</sup>	= <sup>c</sup>	= <sup>c</sup>	= <sup>c</sup>	= <sup>b</sup>	= <sup>c</sup>	= <sup>c</sup>	= <sup>c</sup>
<b>BMI Effects Results</b>	= <sup>b</sup>	NE	NE	NE	= <sup>c</sup>	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
<b>CT Order to Complete</b>	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	↓ <sup>c</sup>	NE	NE	NE
<b>LOS</b>	NE	NE	NE	↓ <sup>b</sup>	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
<b>Nausea/Vomiting</b>	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	↓ <sup>c</sup>	NE	NE	NE
<b>ABCT required repeat</b>	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0

**LEGEND**

1=Anderson, S., et al; 2=Buttigieg, E.L., et al; 3=Kammerer, S. et al; 4=Kepner, AM., et al; 5=Wolfe, J., et al; 6=Allen, TL, et al; 7=Hill, BC., et al; 8=Holmes, JF., et al; 9=Laituri, CA, et al; 10=Latifi, A., et al; 11=Lee, SY, et al; 12=Stuhlfaut, JW., et al; 13=Anderson, BA, et al.; 14=Hlibczuk, V. et al; 15=Lee, CH, et al; 16=Glauser, J., et al

ABCT=Abdominopelvic CT; OC=Oral Contrast; IVC=Intravenous Contrast; TAT= CT Turnaround time; LOS = ED Length of Stay; BMI= Body Mass Index; NE=Not Evaluated; NR=Not Reported; \*=Except suspected bowel leakage

<sup>a</sup>Higher-level evidence; <sup>b</sup>Statistically significant findings; <sup>c</sup>Statistical significant not reported

*Appendix E*

Table 5

*Timeline of Evidence-Based Practice Project*

	December	January	February	March	April
Form Document submitted to IRB					
Presentation to Nursing Research Council					
Initial data collection: Oral contrast utilization, financial impact, top providers					
Development of Initial Algorithm based on current practice					
Identification of Key Stakeholders and send meeting invites					
Meeting to review current process, statistics, initial guideline, process considerations, and potential barriers to implementations and develop implementation plan					
Revise Guideline as needed					
Development of education for ED and radiology providers, medical imaging technologists, and nursing					
Conduct education					
Implement new guideline for oral contrast in abdominopelvic CTs					
Obtain 30 days post implementation data and review					
F/U Meeting to review impact data and determine if move guideline to standard of practice					
Evaluation of project					

■ **Figure 4.1** Human Subjects Research Assessment Form

Figure 4.1. Human Subjects Research Assessment form of OSU to determine if quality improvement projects constitutes as human subjects research.

Figure 4.1. Human Subjects Research Assessment form of OSU to determine if quality improvement projects constitutes as human subjects research.

*Appendix G***Stakeholder Evaluation of Oral Contrast Guideline for Abdominopelvic CTs**

Role: \_\_\_\_\_

	Poor	Fair	Moderate	Good	Very Good
<i>On a scale of 1 to 5, please rate the following items:</i>					
• Thoroughness of guideline to cover key considerations	1	2	3	4	5
• Applicability to clinical practice	1	2	3	4	5
• Ease of understanding for provider	1	2	3	4	5
• Likelihood of changing practice	1	2	3	4	5

Are any variables missing (circle)?    YES    NO  
 If yes, please describe:

*Best way to disseminate guideline (circle):*

E-mail      Provider Meeting      Posted on Unit      In Person

*Comments:*